400SD/SP

OSCILLATOR

Instruction Manual

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- Elgar is promptly notified of defects by the Buyer and that notification occurs within the warranty period;
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- To return a defective product, contact an Elgar representative or the Elgar factory for an RMA number. Unauthorized returns will not be accepted and will be returned at the shipper's expense.
- For Elgar products found to be defective within thirty days of receipt by the original purchaser, Elgar will absorb all ground freight charges for the repair. Products found defective within the warranty period, but beyond the initial thirty-day period, should be returned prepaid to Elgar for repair. Elgar will repair the unit and return it by ground freight pre-paid.
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- Equipment purchased in the United States carries only a United States warranty for which repair must be accomplished at the Elgar factory.

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COMPLETION OF THE 400SD OR 400SP MODEL NUMBER

"THREE DIGIT OPTIONS CODE"

400SD- 1 1 1

MODEL 400SD OR 400SP

0 - No external programming

1 - External resistance programming
0 to 13K ohm for 0 to full scale

2 - External voltage programming
0 to 10VDC for 0 to full scale

3 - External voltage programming
0 to 13VDC for 0 to 130V output

4 - External voltage programming
0 to 26VDC for 0 to 260V output

5 - External resistance programming
0 to 10K ohm for 0 to 130V output

0 - No remote sense with servo control

1 - 1 Phase remote sense with servo control

2 - 2 Phase remote sense with servo control

3 - 3 Phase remote sense with servo control

4 - 3 Phase open DELTA

5 - 3 Phase open DELTA remote sense with servo control

6 - Local front panel control for output range change

1 - 0 to 130V output of power source

2 - 0 to 260V output of power source

3 - 0 to 32V output of power source

4 - 0 to 65V output of power source

5 - Frequency range of 400SD extended to 15Hz to 10KHz

6 - 15Hz to 5KHz extended range

7 - 45Hz to 10KHz extended range

Note that options -001, -002, -003 and -004 have no impact on the 400SD or 400SP oscillators themselves and are only used for general clarification of the power amplifier and oscillator combinations.

SAMPLE MODEL NUMBERS:

401SD-111	Single Phase, resistance program, servo control 0-130V output
403SP-400-402	Three Phase, fixed 400Hz, voltage programming 0-26VDC, no servo control, 0-260V output
403SD-103	Three Phase, resistance programming, 0-13K ohms, no servo control, 0-32V output
401SD-002	Standard oscillator with no options indicating that the accompanying power amplifier jumpered for the 0-260VAC output voltage.

Refer to Section I for operational descriptions of optional features.

MODEL 400SD/SP OPTIONS

1. EXTERNAL RESISTANCE PROGRAMMING OF OUTPUT AMPLITUDE:

   a. 0 to 13K ohms for 0 to full scale
      (100 ohms per volt for 130 volt output)
      Note that three phase is simultaneous control.

   b. Includes J1 mating connector P/N 856-112-9M 1 each Molex connector.
      856-111-8M 12 each Female Pins.

2. EXTERNAL VOLTAGE PROGRAMMING OF OUTPUT AMPLITUDE:

   a. 0 to 10 volts input for 0 to full scale output
   b. 0 to 13 volts input for 0 to 130 volt output

   c. 0 to 26 volts input for 0 to 260 volt output
   d. Includes J1 mating connector P/N 856-112-9M 1 each Molex Connector.
      856-111-8M 12 each Female Pins.

   e. Note that in three phase systems the external voltage controls
      all three phases simultaneously.

3. REMOTE SENSE OF OUTPUT AMPLITUDE WITH SERVO CONTROL: SINGLE PHASE**

   a. Requires remote sense cable 998-091-90 for 1 unit
   b. Requires remote sense cable 998-098-90 for 2 units

4. REMOTE SENSE OF OUTPUT AMPLITUDE WITH SERVO CONTROL FOR TWO PHASE OR THREE PHASE**

   a. Servo control is for each phase line to neutral
   b. Two phase requires remote sense cable 998-092-90 for 1 unit

   c. Two phase requires remote sense cable 998-090-90 for 2 units
   d. Three phase requires remote sense cable 998-093-90 for 1 unit

   e. Three phase requires remote sense cable 998-089-90 for 3 units

5. RESISTANCE PROGRAMMING & REMOTE SENSE FOR SINGLE PHASE**

   a. Combines 1 and 3
   b. Requires remote sense cable 998-103-90 for 1 unit
   c. Requires remote sense cable 998-104-90 for 2 units

6. VOLTAGE PROGRAMMING & REMOTE SENSE FOR SINGLE PHASE:

   a. Combines 2 and 3

   b. Requires remote sense cable 998-103-90 for 1 unit

   c. Requires remote sense cable 998-104-90 for 2 units

7. RESISTANCE PROGRAMMING & REMOTE SENSE FOR TWO OR THREE PHASE **

   a. Combines 1 and 4

   b. Servo control is for each phase line to neutral

   c. Two phase requires remote sense cable 998-105-90 for 1 unit

   d. Two phase requires remote sense cable 998-106-90 for 2 units

   e. Three phase requires remote sense cable 998-107-90 for 1 unit

   f. Three phase requires remote sense cable 998-108-90 for 2 units

8. VOLTAGE PROGRAMMING & REMOTE SENSE FOR TWO & THREE PHASE **

   a. Combines 2 and 4

   b. Servo control is for each phase line to neutral

   c. Two phase requires remote sense cable 998-105-90 for 1 unit

   d. Two phase requires remote sense cable 998-106-90 for 2 units

   e. Three phase requires remote sense cable 998-107-90 for 1 unit

   f. Three phase requires remote sense cable 998-108-90 for 3 units

**The REMOTE SENSE OF OUTPUT AMPLITUDE WITH SERVO CONTROL options provide the following voltage control specifications:

1.	Load Regulation:	+/- 0.015% of full scale change from no load to full load at point of sense
2.	Line Regulation:	+/- 0.01% of full scale change for a 10% line change within normal input line range.
3.	Amplitude Temperature Coefficient:	+/- 0.01% per degree C average 0 degree C to 50 degrees C

4. Remote sense with servo control options require separately priced remote sense cables:

   a. 1 Phase (single unit, e.g., 251B).....998-091-90
   b. 1 Phase (single unit with R or V Programming).....998-103-90
   c. 1 Phase (2 units, e.g., 6000-1).....998-098-90
   d. 1 Phase (2 units with R or V Programming).....998-104-90
   e. 2 Phase (single unit, e.g., 153B).....998-092-90
   f. 2 Phase (single unit with R or V Programming).....998-105-90
   g. 3 Phase (single unit, e.g., 1753B).....998-093-90
   h. 3 Phase (single unit with R or V Programming).....998-106-90
   i. 2 Phase (2 units, e.g., 240-2).....998-090-90

j. 2 Phase (2 units with R or V Programming).....998-107-90

k. 3 Phase (3 units, e.g., 3000-3).....998-089-90

l. 3 Phase (3 units with R or V Programming).....998-108-90

NOTE: All amplitude measurements and accuracies based on full wave average.

Note that options -001, -002, -003 and -004 have no impact on the 400SD or 400SP oscillators themselves and are only used for general clarification of the power amplifier and oscillator combinations.

SAMPLE MODEL NUMBERS:

401SD-111	Single Phase, resistance program, servo control 0-130V output
403SP-400-402	Three Phase, fixed 400Hz, voltage programming 0-26VDC, no servo control, 0-260V output
403SD-103	Three Phase, resistance programming, 0-13k ohms, no servo control, 0-32V output
401SD-002	Standard oscillator with no options indicating that the accompanying power amplifier jumpered for the 0-260VAC output voltage.

ADDENDUM

The Model 401SD-005 is a modified version of the Standard Variable Oscillator.

The frequency range of this oscillator has been extended and is variable from 15 HZ to 10 KHZ. This extended range is accomplished by replacing R19 (90.9Kohm) with a 332Kohm resistor and removing C12 on the Synthesized board.

Document Number: 604-203-90

Model Affected: 400SD/SP w/Servo

Description of Change:

The various models of the 400SD/SP oscillators may be enhanced by the addition of a servo board which allows the voltage at the load to be sensed and corrected for load variations.

DANGER - HIGH VOLTAGE is exposed when Power Source Top Cover is removed for servicing or calibration.

Resistance and Voltage programming are covered in the basic 400SD/SP Manual so they will not be covered in this text except for understanding when they are combined with a servo board.

Circuit Descriptinn

With a single phase servo installed, R54 on the basic oscillator board has been removed input side is now connected to the servo board (Schematic 604004) A PHASE INPUT. The ServoBoard AØ output is now connected to the right side of where R54 was located. Thus a variable gain amplifier has been added in series with the A phase output. This is servo board U6 pins 1,2 and 3.

The IOV input to the servo board comes from the internal reference of the basic oscillator. It is dropped to 6.9 volts by CR1 and then boosted back to 10 volts by U10 pins 5,6 and7. This is done to create a very stable (.004 percent per degree C) reference. This is sent back to the basic oscillator via 10V RET to be used as the reference for amplitude control.

The output of the reference amplifier is returned to the servo board via the -REF input. This same reference is used to control the output amplitude of Digital to Analog Converter, U14 in the basic oscillator. This output is returned to the servo board via A phase input.

When there is an open servo condition, U6 Pin 7 will be maximum positive due to the output of U10 Pin 1. This will cause photomodulator U5 to have minimum resistance between pins 5 and 6. This in turn will cause U6 pins 1,2 and 3 to have maximum gain.

When the servo feedback is connected, it appears at servo board R6 and R7. Intergrated circuit U13 and associated components form a Differential Amplifier with a rectified output. This feedback will cause U6 pin 7 to move in a negative direction until the output gain at U6 pin 1 is reduced to the point where there is circuit equalibrium.

SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 The Series 400SD variable frequency oscillators are plug-in units which provide variable frequency signals for the Elgar AC Power Sources. The frequency is determined by four decade switches on the front panel.

1.1.2 The Series 400SP oscillators are plug-in units which provide fixed frequency signals for the Elgar AC Power Sources. The frequency may be changed by setting DIP switches internal to the oscillator.

1.1.3 The output amplitude of the 400SD or the 400SP is uncalibrated and is adjusted by the gain potentiometer on the front panel of the associated power source.

1.2 SCOPE OF MANUAL

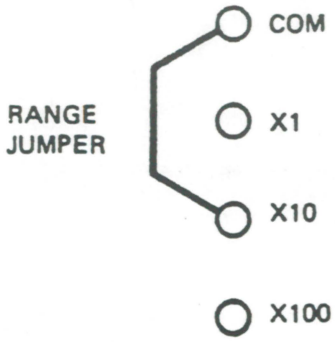
1.2.1 This manual describes the Elgar Series 400SD and Series 400SP oscillators. It includes specifications, operating instructions, circuit descriptions, circuit diagrams, maintenance information and parts lists.

1.3 GENERAL DESCRIPTION OF OPERATION

1.3.1 The 400SD oscillator plugs into the front panel of the Elgar power source and is secured by two captive screws. Frequency output of the Model 400SD is controlled by four decade switches and a X1, X10, X100 frequency range switch. The decimal for reference is silkscreened on the oscillator front panel between the center two decade switches. Frequency resolution is 1 part in 10,000.

The frequency limit LED on the front panel of the oscillator will light if a frequency below 44 Hz or a frequency above 5100 Hz is selected. If this occurs, the output of the oscillator will drop to zero. When a proper frequency is selected, the Limit light will go out and the oscillator output will rise at an exponential rate to full output in about 250 milliseconds.

1.3.2 The 400SP oscillator plugs into the front panel of the Elgar Power Source and is secured by two captive screws. Frequency output is controlled by two 8 position DIP switches which are internal to the oscillator. These are inverted logic, thus the off position of the switch enables the bit. The code for these switches is shown in Figure 1-1. The Range is set by a jumper which is also shown in Figure 1-1. The X1 to Com sets the 45 to 99.99 Hz range, the X10 to Com sets the 45 to 999.9 Hz range and the X100 to Com sets the 45 Hz to 5 kHz range.



NOTE: Inverse logic = OFF = Set Bit

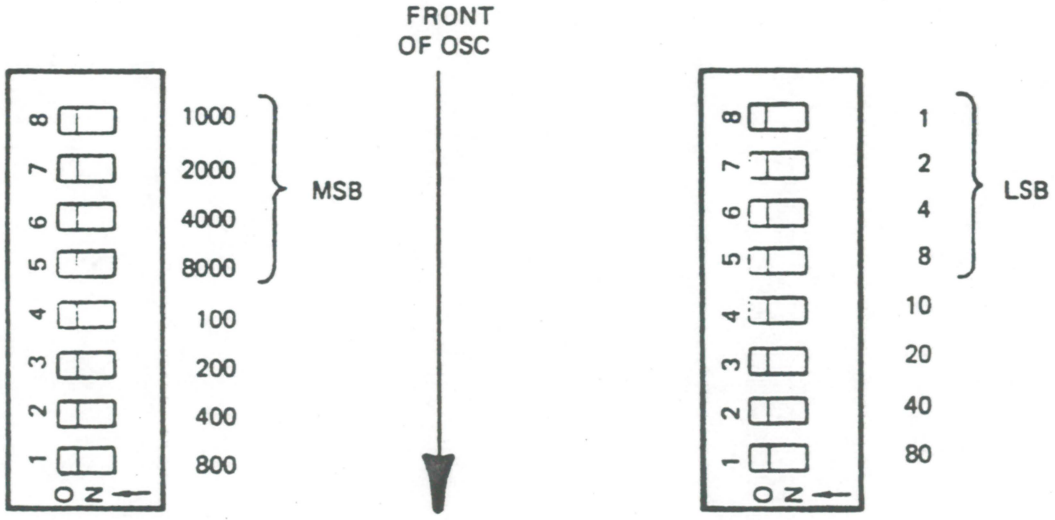


Figure 1-1

1.4 RESISTANCE PROGRAMMING

1.4.1 When the Model 400SD/SP has been equipped for resistance programming, the output amplitude of the power source may be varied by changing the value of an external resistor connected between Pins 7 and 8 of connector J1 on the rear of the power source. The value of this resistor is 100 ohms per volt on the 130V output range and 50 ohms per volt on the 260V output range. The associated power source will have the Gain knob removed and a shaft lock installed. This potentiometer now becomes the full scale calibration and R8 in the oscillator is 10% of scale calibration. Note: In the Model 400SD these calibrations will be affected by changing frequency.

1.5 VOLTAGE PROGRAMMING

1.5.1 When a Model 400SD/SP is equipped for voltage programming, the output of the power source may be controlled by a positive input voltage applied to Pin 6 with common to Pin 1 of J1 on the rear of the power source. The associated power source will have the Gain knob removed and a shaft lock installed. This is the full scale adjustment for voltage programming and may be set so that +10 volts equals 130V out or where +13V equals 130V out. This also applies to the 260V output range where +10V equals 260V or +26 equals 260V out. The 10% of the FS adjustment is R8 on the oscillator.

1.6 TANDEM OPERATION

1.6.1 All model 400SD/SP are equipped for tandem operation. Pins 9 and 14 of the oscillator are connected together.

1.7 SPECIFICATIONS

1.7.1 Specifications for the Series 400SD/SP are listed in Table 1-1.

TABLE 1-1. SPECIFICATIONS

Output Signal Amplitude	Approximately 2V RMS
Harmonic Distortion	Less than 0.25% of oscillator output 45 Hz to 5 kHz
Frequency Accuracy	±0.001% of set value
Temperature Coefficient:	
Of output frequency	±0.0003%/°C
Of output amplitude	±0.02%/°C
Frequency Ranges	X1 Range 45 Hz to 99.99 Hz X10 Range 45 Hz to 999.9Hz X100 Range 45 Hz to 5000 Hz*

MODEL	OUTPUT CONFIGURATION
401SD/SP	1 Phase
402SD/SP	2 Phase
403SD/SP	3 Phase

*In Series 400SD this will be set to conform with upper full power frequency limit of associated power source and can be disabled for operation to 9999 Hz.

SECTION II
PRELIMINARY INSPECTION AND OPERATION

2.1 INSPECTION UPON RECEIPT

2.1.1 The Elgar plug-in oscillators are aligned, calibrated, and tested prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure the instrument has suffered no damage during shipment.

2.1.2 Make a visual inspection of the shipping container prior to accepting the package from the carrier. If extensive damage to the shipping container is evident, a description of the damage should be noted on the carrier's receipt, and signed by the driver or carrier agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier and all shipping containers and filler material saved for inspection. Forward a report of damage to the Elgar Repair Department, who will provide instructions for repair or replacement of the instrument.

2.1.3 Visually inspect instrument for physical damage when it is removed from shipping container. Test functional operation of instrument as soon as possible. If damage is evident, or instrument does not function properly, notify the carrier immediately. Carrier's claim agent will prepare a report of damage to be forwarded to the Elgar Repair Department. You will be advised as to the action necessary to have the instrument repaired or replaced.

2.2 INSTALLATION

2.2.1 The oscillator is quickly and easily installed by plugging it into the space provided on the front panel of the Elgar power source. When the oscillator is fully inserted, and the captive screws secured, the unit is ready for operation.

NOTE

Remove power from amplifier when installing oscillator.

2.3 OPERATION

2.3.1 After installation in the Elgar power source, the oscillator operates automatically, receiving its power from the power source and requiring only that the front panel controls be set for the desired frequency and range. The amplitude of the power source output is controlled by the AMPLITUDE control on the front panel of the power source.

2.4 INTERCONNECTIONS FOR TWO OR THREE PHASE OPERATION

2.4.1 Three-phase oscillator may be installed directly in Elgar three-phase power sources without special connections. Where two-phase or three-phase power sources are made up by stacking two or three of the Elgar single-phase power sources, the oscillator is installed in the A-phase power source. Oscillator signals are carried to the B-phase and C-phase power sources through a cable (furnished with the oscillator) interconnecting the Jones S312AB sockets on the rear panels of the power source. The B-phase and C-phase sources must have Model 400B and 400C dummy plug-ins installed to complete the signal interconnection. The front panel AMPLITUDE control on the A-phase power source acts as a master control to vary all the outputs simultaneously, while the B-phase and C-phase AMPLITUDE controls act merely as balance controls to set the B-phase and C-phase output voltages equal to the A-phase output voltage.

2.4.2 With those single-phase Elgar power sources which have dual output windings, two power sources may be interconnected for three-phase wye operation. One of the output windings on each of the A-phase and B-phase sources is used for the A-phase and B-phase outputs. The C-phase output is sythesized by inverse series connection of the remaining two windings, as diagrammed in Figure 2-1.

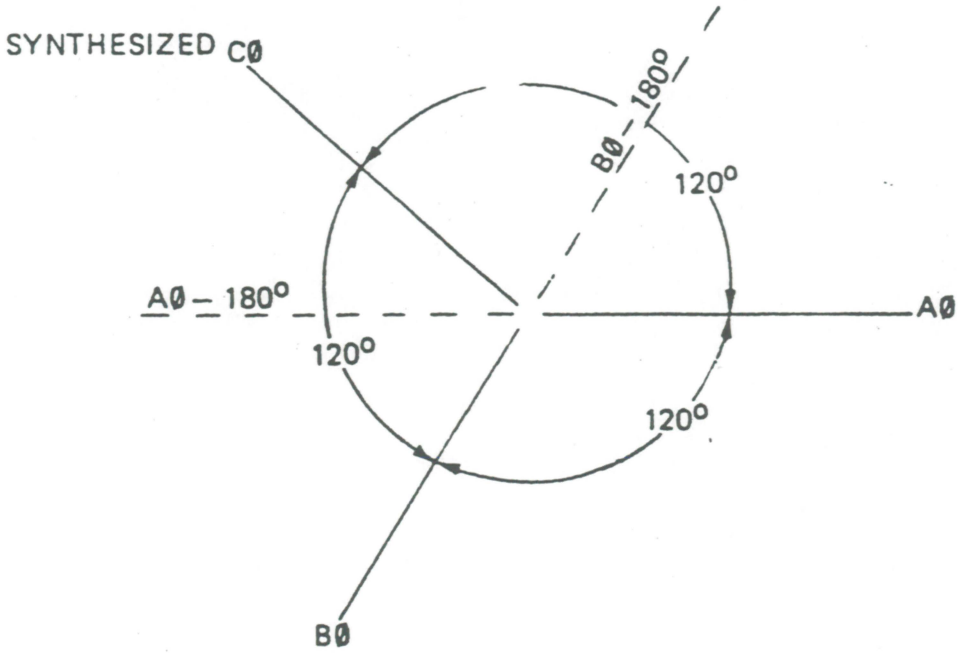


Figure 2-1. 2 Amplifier 3Ø Wye Configuration

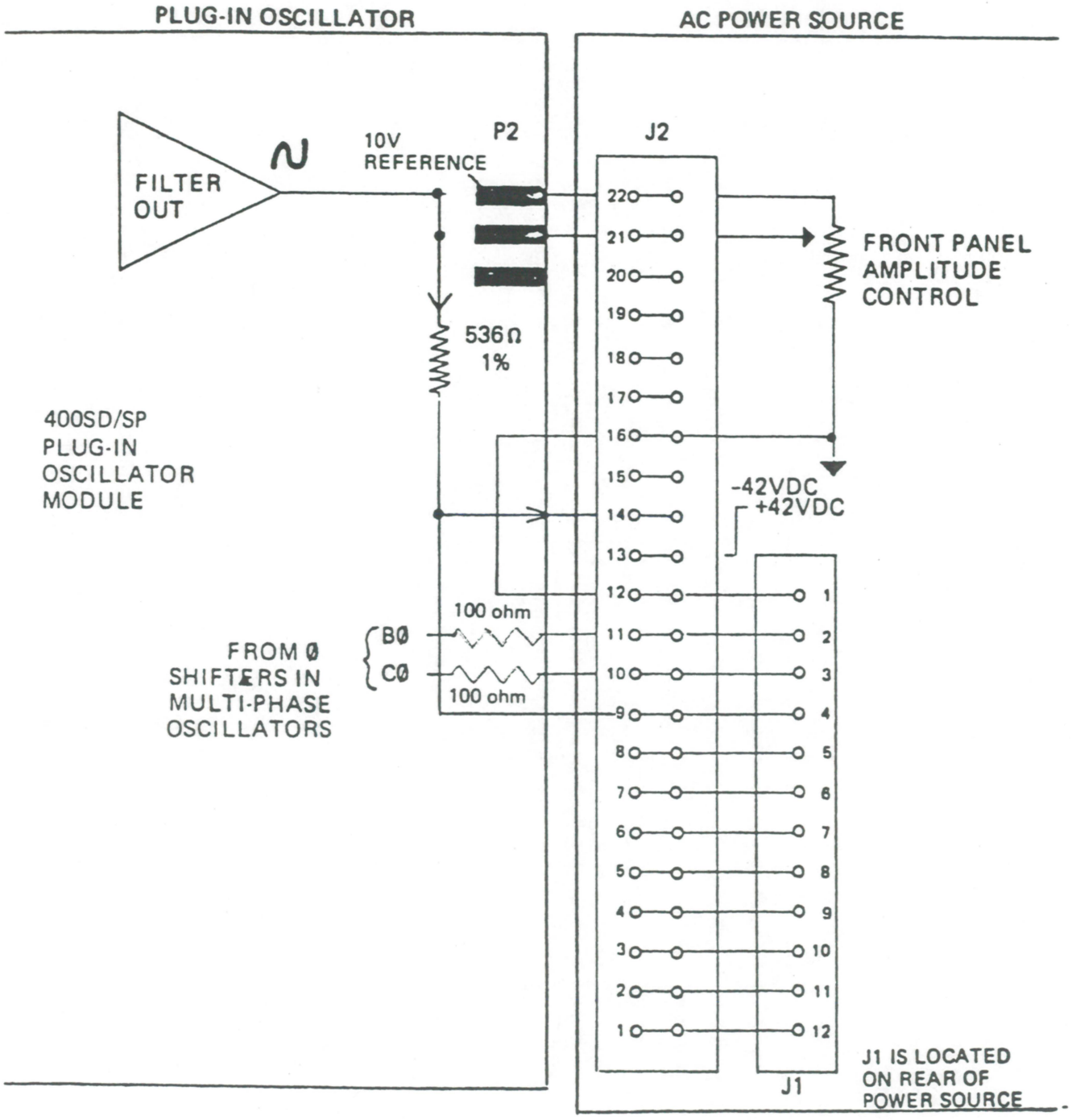


Figure 2-2. Typical Plug-in Oscillator/Power Source Interconnection

SECTION III
THEORY OF OPERATION

3.1 OSCILLATOR CIRCUIT

3.1.1 The oscillator output contains 1024 bits or steps per cycle which have been synthesized from a fixed 10.24 MHz crystal oscillator. This gives a frequency accuracy of 0.001%.

3.1.2 The synthesis starts with the 10.24 MHz crystal oscillator which drives the Rate Multipliers U1, U2, U4 and U5. These rate multipliers will produce an output at U3B pin 8 which is proportional to the formula: Output equals crystal frequency divided by the quantity 10,000 multiplied by the BCD input from the switches. As an example: If the switches are set to 4000, the output at U3 pin 8 will be 4.096 MHz.

3.2.3 The frequency Range is controlled by U13A, U13B and S7. S7 allows direct through, divide by 10 or divide by 100 of the Rate Multiplier output. In the example of 4.096 MHz out of the Rate Multipliers, if we use the divide by 10 position of the switch S7, we will have 409.6 kHz to U10 pin 5.

3.1.4 Binary counters U10,U11 and U12 are up/down counters which are counting up only. U10 and U11 are counting by 256 for each quarter wave of the output signal and U12 is counting by 4 for each full cycle of the output frequency. This is a total count of 1024 per output cycle. Thus in the example the 409.6 kHz is counted to 400 Hz in the output.

3.1.5 The outputs of the binary counters are controlled by exclusive OR gates U6 and U7 which, when controlled by U12 pin 3, create the equivalent of an up/down drive to U9.

3.1.6 Integrated circuit U9 is a 256 by 8 Prom which has been programmed with a sine look-up table. When the address input lines are driven by U6 and U7, it will produce the digital output code for a sine table.

3.1.7 The digital outputs of the sine Prom drive multiplying digital to analog converter (DAC) U14. When U14 is thus driven, it will put out a current waveform which is proportional to the digital input multiplied by the reference current input through R52.

3.1.8 The current waveform out of DAC U14 is converted to a voltage waveform by amplifier A1B. This waveform will be a series of half wave, positive going signals. See timing diagram Figure 3-2 waveform B. This series of half wave signals is fed to amplifier A1A.

3.1.9 Amplifier A1A is an invert/noninvert amplifier with a gain of one. When enhancement mode FET Q3 has a positive on the gate, the source to drain resistance is very low. Thus if Q3 is on, pin 3 is shorted to common and the circuit is a normal inverting operational amplifier. Conversely, when Q3 is off, A1A will act as a non-inverting operational amplifier. Thus when waveform A of timing diagram (Figure 3-2) is applied to Q3 in synchronization with the analog signal of waveform B, the result will be the sine wave of waveform C on the output. This is filtered by the two pole filter of A2A and becomes the A phase output.

3.2 MULTI-PHASE OPTION

3.2.1 On the phase board, U1 is a Prom with a cosine look-up table. This is driven by the same address lines as is the sine prom of the basic oscillator. Thus the generation of the D phase, or -90° phase is done in the same manner as the A phase.

3.2.2 Differential amplifier A5B takes the difference of the -90° phase and the A phase and produces a B phase which is +240 degrees from the A phase.

3.2.3 Amplifier A6B takes the +240° B phase and the 0° A phase and produces the difference which is the C phase at +120°.

3.3 FREQUENCY DETECTOR CIRCUIT (Model 400SD only)

3.3.1 Each half wave of the output frequency will cause U8 pin 6 to produce a narrow plus going spike. This will retrigger U15B which is a retriggerable monostable multivibrator. So long as the frequency is high enough, U15B will never time out. When the output frequency drops below 45 Hz, U15B will time out and U16B will clock in this information. When U16 is set, the front panel LED FREQUENCY LIMIT LIGHT will come on and the reference voltage will shut down which in turn shuts down the oscillator. When the frequency is selected back into limit, Q1 will turn off and the reference voltage will rise at the rate set by R14 and C8. This causes a soft-start of the power source.

3.3.2 The high frequency limit works in the opposite manner to the low frequency limit. Monostable multivibrator U15A must time out before the next pulse or the frequency is too high. If U15A has not timed out, the next pulse from U8 pin 6 will clock U16A and it will in turn, drive Q1 into the limit condition shutting down the oscillator output.

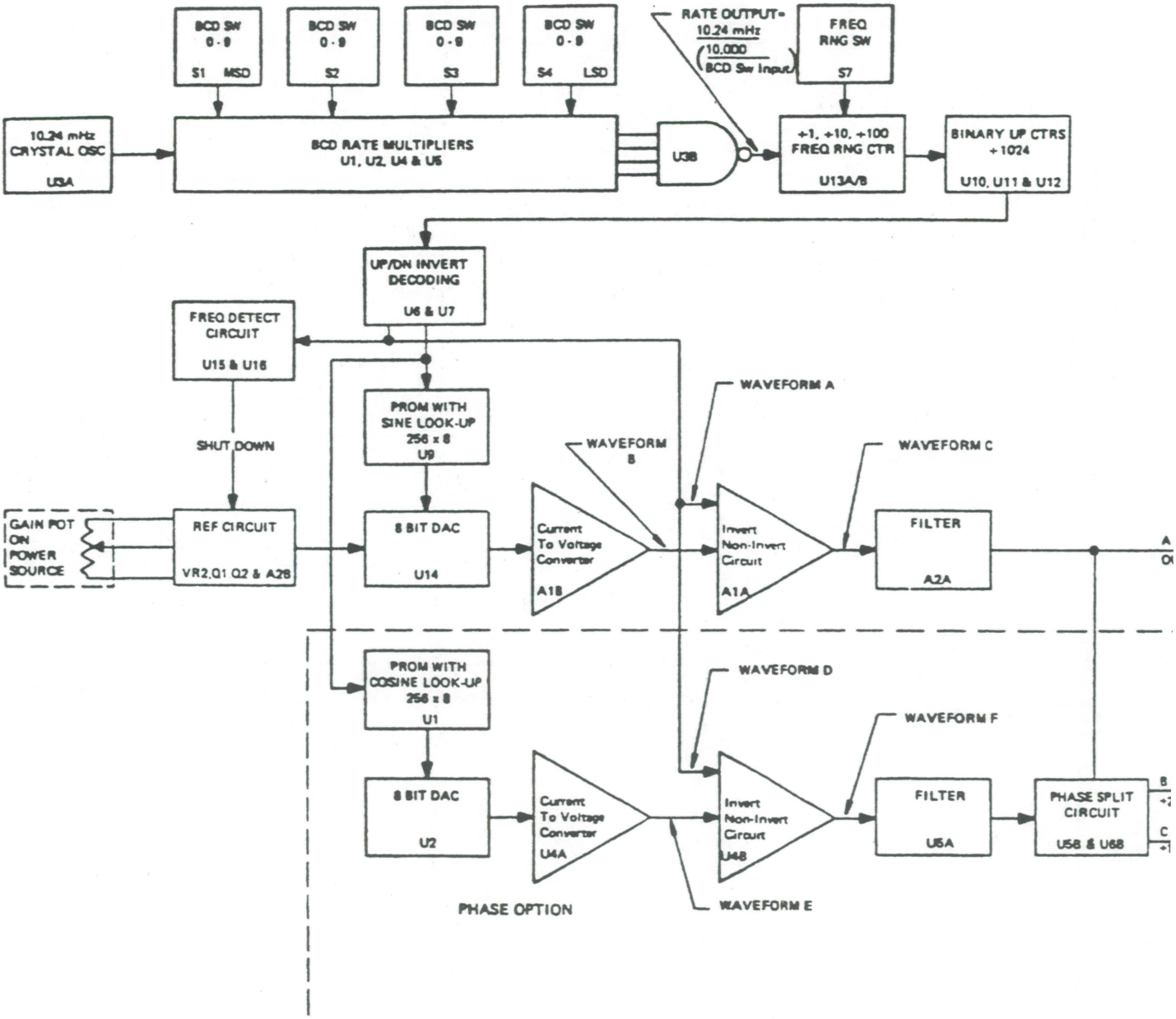

BCD SW 0-9 S1 MSD
BCD SW 0-9 S2
BCD SW 0-9 S3
BCD SW 0-9 S4 LSD
RATE OUTPUT= 10.24 mHz / (10,000 / BCD Sw Input)
FREQ RNG SW S7
10.24 mHz CRYSTAL OSC U3A
BCD RATE MULTIPLIERS U1, U2, U4 & U5
U3B
+1, +10, +100 FREQ RNG CTR U13A/B
BINARY UP CTRS +1024 U10, U11 & U12
UP/DN INVERT DECODING U6 & U7
FREQ DETECT CIRCUIT U15 & U16
SHUT DOWN
PROM WITH SINE LOOK-UP 256 x 8 U9
WAVEFORM A
WAVEFORM B
WAVEFORM C
GAIN POT ON POWER SOURCE
REF CIRCUIT VR2,Q1 Q2 & A2B
8 BIT DAC U14
Current To Voltage Converter A1B
Invert Non-Invert Circuit A1A
FILTER A2A
PROM WITH COSINE LOOK-UP 256 x 8 U1
WAVEFORM D
WAVEFORM F
8 BIT DAC U2
Current To Voltage Converter U4A
Invert Non-Invert Circuit U4B
FILTER U5A
PHASE SPLIT CIRCUIT U5B & U6B
PHASE OPTION
WAVEFORM E

Figure 3-1. 400SD/SP Block Diagram

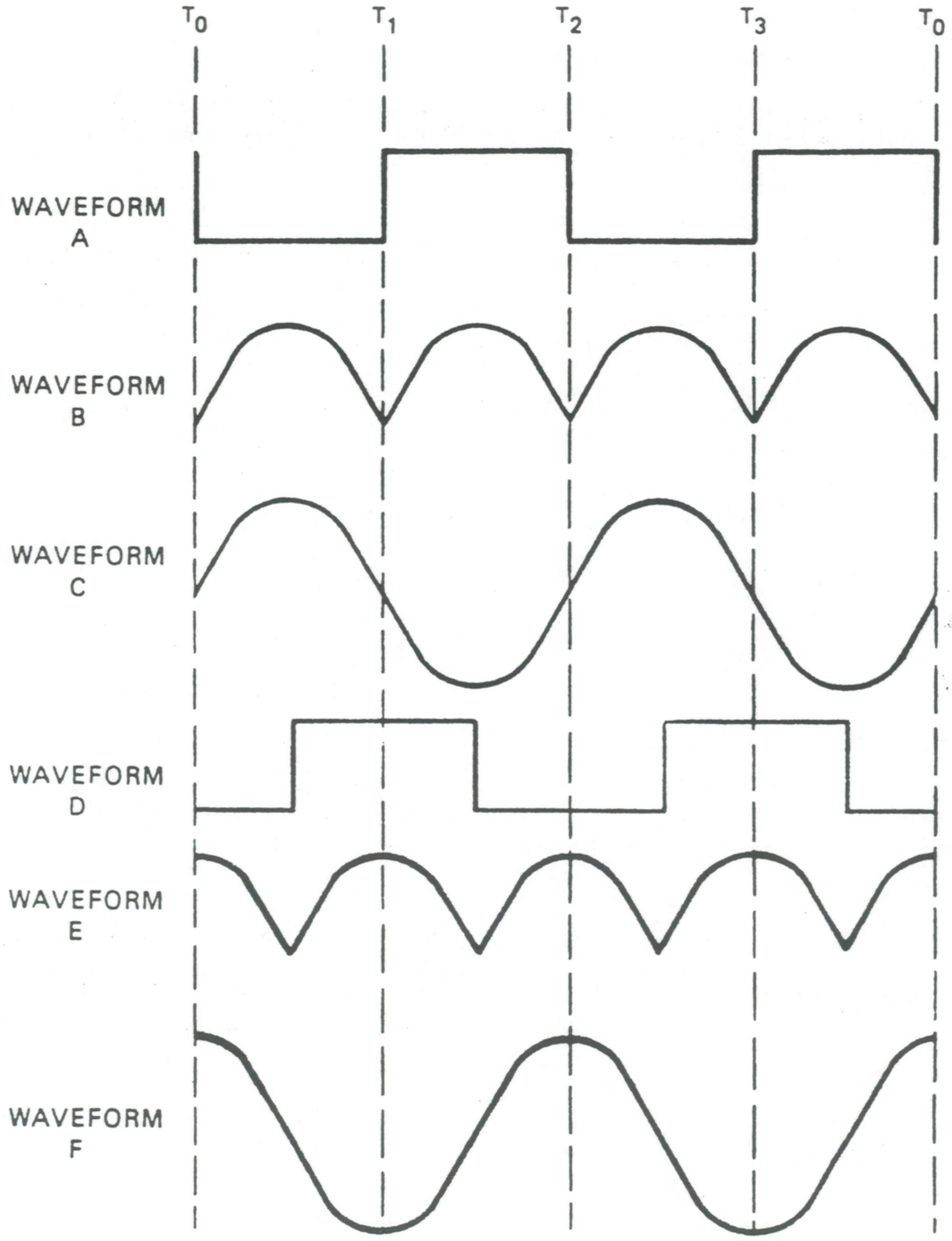


Figure 3-2. Timing Diagram

SECTION IV
MAINTENANCE

4.1 SERVICE INFORMATION

4.1.1 Questions concerned with the operation, repair or servicing of this equipment should be directed to the Elgar Repair Department, Elgar 9250 Brown Deer Road, San Diego CA 92121-2294. Include model number and serial number in any correspondence concerning the instrument.

4.2 FACTORY SERVICE

4.2.1 Should it be necessary to return an instrument to the factory for repair, please contact the Elgar Repair Department for authorization to make shipment. DO NOT RETURN THE UNIT FOR REPAIR WITHOUT AUTHORIZATION.

4.3 SHIPPING DAMAGE

4.3.1 It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be inspected and tested as soon a it is received. If the instrument shows signs of damage, notify the carrier immediately. The carrier's claim agent will prepare a report of damage to be forwarded to the Elgar Service Department. You will be advised as to the action necessary to have the instrument repaired or replaced.

4.4 SINGLE PHASE CALIBRATION

4.4.1 Single phase calibration for the 400SP is as follows:

1. Turn R10 fully counterclockwise and front panel Gain fully clockwise.
2. Turn S5-1 off and all other S5 and S6 switches on (sets 800 Hz).
3. Monitor A phase output with Distortion Analyzer (TP1).
4. Turn power on and adjust R10 so power source output is approximately 132V RMS.
5. Adjust R45 for minimum distortion output.
6. Adjust R51 for minimum distortion output.

4.4.2 Single phase calibration for the 400SD is as follows:

1. Turn R10 fully counterclockwise and front panel Gain fully clockwise.
2. Select 800 Hz on X10 range.
3. Monitor A phase output with Distortion Analyzer (TP1).
4. Turn on power and adjust R10 for approximately 132V RMS output.
5. Adjust R45 for minimum distortion output.
6. Adjust R51 for minimum distortion output.
7. Set oscillator to 45.00 on X1 range.
8. Turn R20 clockwise until front panel Freq Limit comes on, then turn counterclockwise until light just goes off.
9. Set Frequency to 51.00 on X100 range. Turn R17 counterclockwise until front panel Freq. Limit comes on, then turn clockwise until Freq Light just goes off.

4.5 PHASE BOARD CALIBRATION

4.5.1 Phase board calibration for the 400SD/SP is as follows:

1. Add phase board to tested 400SD/SP oscillator.
2. Set oscillator to 800 Hz and monitor phase board TP1 with Distortion Analyzer. Apply power.
3. Adjust R9 for minimum distortion output.
4. Adjust R10 for minimum distortion output.
5. Monitor main board TP1 with AC DMM and record reading (not required on recalibration).
6. Monitor phase board TP1 with AC DMM and adjust phase board R6 so reading is the same as recorded in previous step (not required on recalibration).
7. Set oscillator output frequency to 5 kHz (customer desired frequency in Model 400SP).
8. Connect phase angle meter with reference input to A phase TP1 and signal input to phase board TP1.
9. Adjust phase board C9 so phase angle is -90° (+270°).

10. Reduce oscillator frequency to 50 Hz. (Leave Model 400SP at customer desired frequency.)

11. Move phase angle meter signal input to C phase output.

12. Adjust R6 for +120 phase angle.

4.6 RESISTANCE PROGRAMMING CALIBRATION

4.6.1 Connect a 13K ohm precision resistor between pins 7 and 8 of J1 on rear of power source. Turn on power.

4.6.2 Adjust locking Gain potentiometer on front panel of power source for 130V RMS output.

4.6.3 Change 13K ohm resistor to a 1K ohm resistor and adjust R8 on oscillator for 10V RMS output.

4.6.4 Repeat steps 4.6.1, 4.6.2 and 4.6.3 as required to compensate for interaction of adjustments. Set lock on power source front panel Gain.

4.7 VOLTAGE PROGRAMMING CALIBRATION

4.7.1 Apply +10VDC* to pin 6 with common to pin 1 of J1 on rear of power source. Turn on power.

4.7.2 Adjust locking Gain potentiometer on front panel of power source for 130V RMS output.

4.7.3 Reduce +10VDC* to +1VDC* and adjust R8 on oscillator for 13V RMS output.

4.7.4 Repeat steps 4.7.1, 4.7.2 and 4.7.3 as required to compensate for interaction. Set lock on power source front panel Gain.

*The voltage programming may be calibrated where +13VDC equals 130V RMS or where +10VDC equals 130V RMS output. This is customers option and is only where locking Gain potentiometer and R8 are set.

4.8 CIRCUIT BOARD COMPONENT LOCATION

4.8.1 Component location diagrams are given for the basic oscillator (Figure 5-1) and for the phase option (Figure 5-2). Those components in Figure 5-1 which are marked 6 are used in the model 400SD only.

4.9 TEST EQUIPMENT REQUIRED

Distortion Analyzer	Krohn-Hite 6800 or equal
Digital Voltmeter	Fluke 8050A or equal
Phase Angle Meter	Dytronics 224 or equal
Frequency Counter	Hewlett Packard 5307A or equal

SECTION V
DIAGRAMS

5.1 GENERAL

5.1.1 This section contains the schematic diagrams for the Series 400SD/SP Plug-In Oscillators. The schematic diagrams should be used to understand the theory of operation and as an aid in troubleshooting the unit. Reference designators shown on schematics correspond to reference designators shown in parts lists where exact component values are given.

5.2 DIAGRAMS

5.2.1 Diagrams included in this section are as follows:

1. Schematic diagram for Model 400SD/SP main board.

2. Schematic diagram for Model 400SD/SP phase board.

5.2.2 The schematics in this section use ○ to indicate P2 connections from the oscillator to J2 in the power source and □ to indicate an interconnection from the oscillator main board to the phase board.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ENG'K REL. P.C.	12-23-81	
	B	ECN 2694 P.C.	5-19-82	
	C	PER ECN 3020 JR.	8-11-82	
	D	ECN 3269 VG	11-2-82	
	E	ECN 4864 GCC 2-21-85	2-25-85	
	F	ECN 5082 GCC 4-23-85	4/29/85	
	G	ECN 5351 SIR 6-13-85	6/14/85	
	G1	ECN 5210 SIR 6-17-85	6-20-85	
	H	ECN 6487 JRANER 87-11-10	1-6-88	
	J	ECN 6580 RCHASE 2-8-88	2-9-88	
	K	REVISED PER ECN 8781	11-7-95	
	L	REVISED PER ECN N980396	4/9/98	

NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS, 1%.
2. CAPACITOR VALUES ARE IN MICROFARADS.
3. -01 ASSY CIRCUITRY ONLY.
4. -02 ASSY CIRCUITRY ONLY.
5. RESERVED FOR SPECIAL APPLICATIONS - REF ONLY.

CONTRACT NO.		ELGAR an Orion power systems company	
FIRST MADE FOR:		SCHEMATIC - SYNTHESIZED PCB	
APPROVAL	DATE		
DRAWN B. PRESCOTT	4/20/88		
CHECKED			
PROJ ENG			
QA-REL			
SIZE D	CODE IDENT. NO. 25965	DRAWING NO. 6040001	REV L
SCALE NONE		SHEET 1 OF 1	

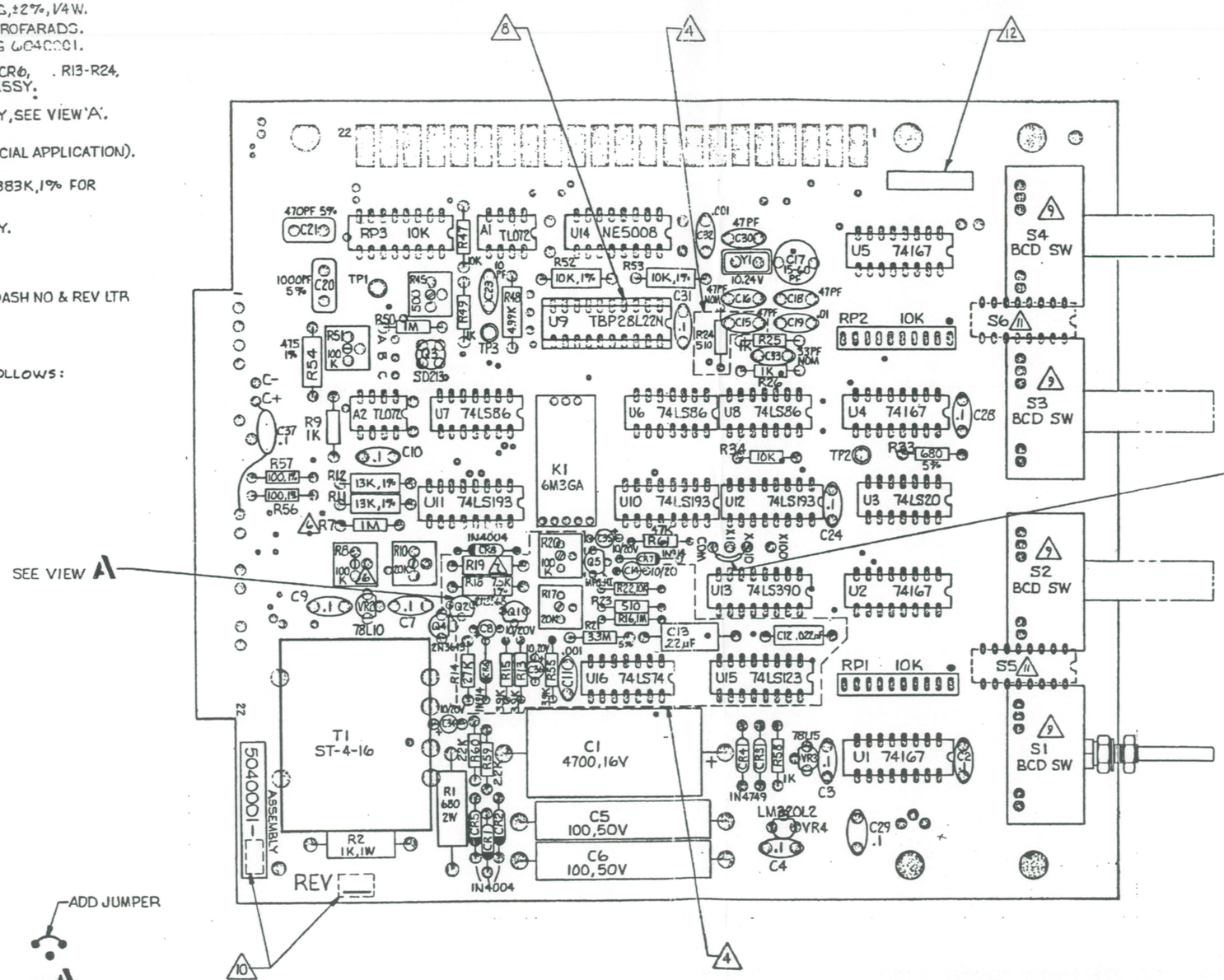
ELGAR 990 219 00

Figure 5-1. Model 400SD/SP Main Board Schematic

NOTES: UNLESS OTHERWISE SPECIFIED

1. RESISTANCE VALUES ARE IN OHMS, ±2%, 1/4W.
2. CAPACITANCE VALUES ARE IN MICROFARADS.
3. FOR SCHEMATIC DIAG., SEE DWG 6040001.
4. DO NOT INSTALL C8, C11-C15, C36, CR6, . R13-R24, R55, Q1, Q2, S1-4, U15 & U16 ON -02 ASSY.
5. DO NOT INSTALL Q2 ON -02 ASSY, SEE VIEW 'A'.
6. R7 & R8 ARE REF ONLY (FOR SPECIAL APPLICATION).
7. R19 (90.9K 1%) IS REPLACED BY 383K, 1% FOR 15 Hz OPERATION ONLY.
8. SOCKET REQUIRED FOR U9 ONLY.
9. -01 ASSY ONLY.
10. IDENTIFY WITH APPROPRIATE DASH NO & REV LTR BY RUBBER STAMP.
11. -02 ASSY ONLY.
12. IDENTIFY LABEL (ITEM 9) AS FOLLOWS:
    5040001-BS REV ___
    S/N ___

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	T	REVISED AND REDRAWN PER ECN 8781	11-7-75	
	U	REVISED PER ECN N980396	4/1/88	



-01 ASSY SHOWN
-02

5041001-04	400SP 3 PHASE
" -03	400SD 3 PHASE
" -02	400SP 1 PHASE
5041001-01	400SD 1 PHASE
NEXT ASSY.	USED ON

APPLICATION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON:
DECIMALS FRACTIONS ANGLES
XX ± .03 ± 1/32 ± 1/2°
XXX ± .010
DO NOT SCALE THIS DRAWING

MATERIAL:

FINISH:

CONTRACT NO.		
FIRST MADE FOR:		
APPROVAL		DATE
DRAWN	J. RAMER	87-11-12
CHECKED		
PROJ ENG		1-6-88
QA-REL		

ELGAR

PRINTED WIRING ASSY, SYNTHESIZED

SIZE	CODE IDENT. NO.	DRAWING NO.	REV
D	25965	5040001	U

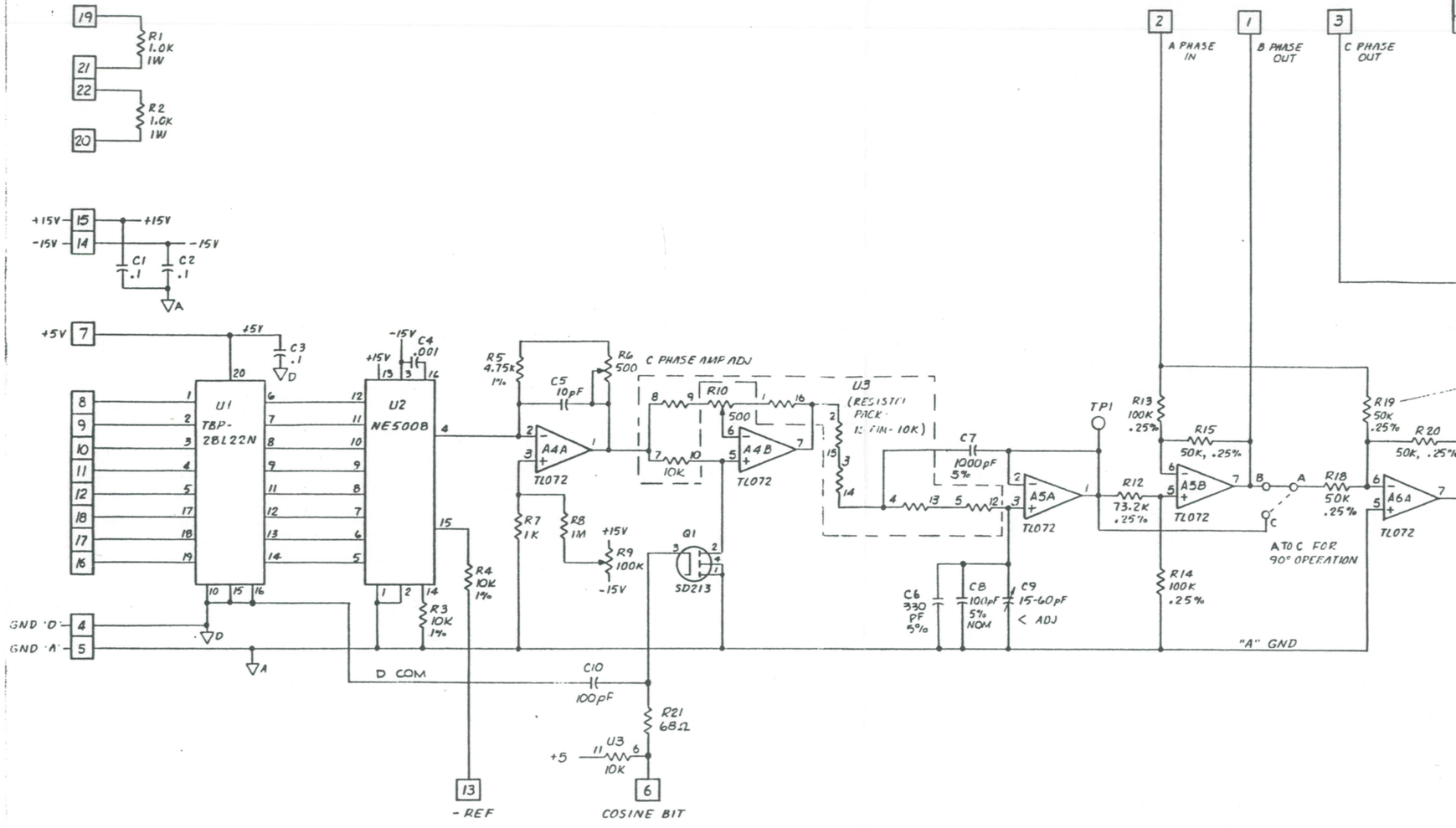
SCALE 2/1 SHEET 1 OF 1

5040001

ELGAR 990 313 90B

Figure 5-2. Model 400SD/SP Main Board Assembly Drawing

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ENG'R. RFL P.C.	[illegible]	[illegible]
	B	PER ECN 3020	[illegible]	[illegible]



NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS
2. CAPACITOR VALUES ARE IN MICROFARADS.
3
4. TL072 VOLTAGE PINS: PIN 4 -15V, PIN 8 +15V.
5. HIGHEST USED REFERENCE DESIGNATOR:
   C9, Q1, R20, TP1, U6
6. I/O ARE TO/FROM SYNTHESIZER OSCILLATOR PCB.

CONTRACT NO.	ELGAR an Otsuka power systems company
SHEET MADE FOR: APPROVAL DATE	
DRAWN D. PRESCOTT 2-24-92	SCHEMATIC - PHASE BOARD
CHECKED	
APPLIED ENG. [illegible] 2-24-92	
QA/REL	
	SIZE D · CODE IDENT. NO. 25965 · DRAWING NO. 6040003 · REV B
	SCALE NONE · SHEET 1 OF 1

Figure 5-3. Model 400SD/SP Phase Board Schematic

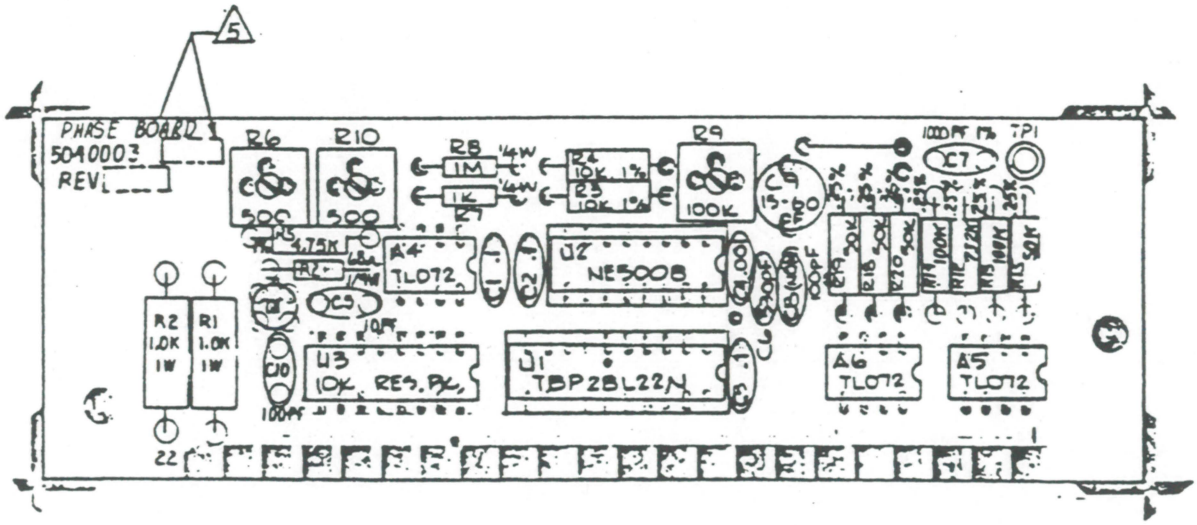
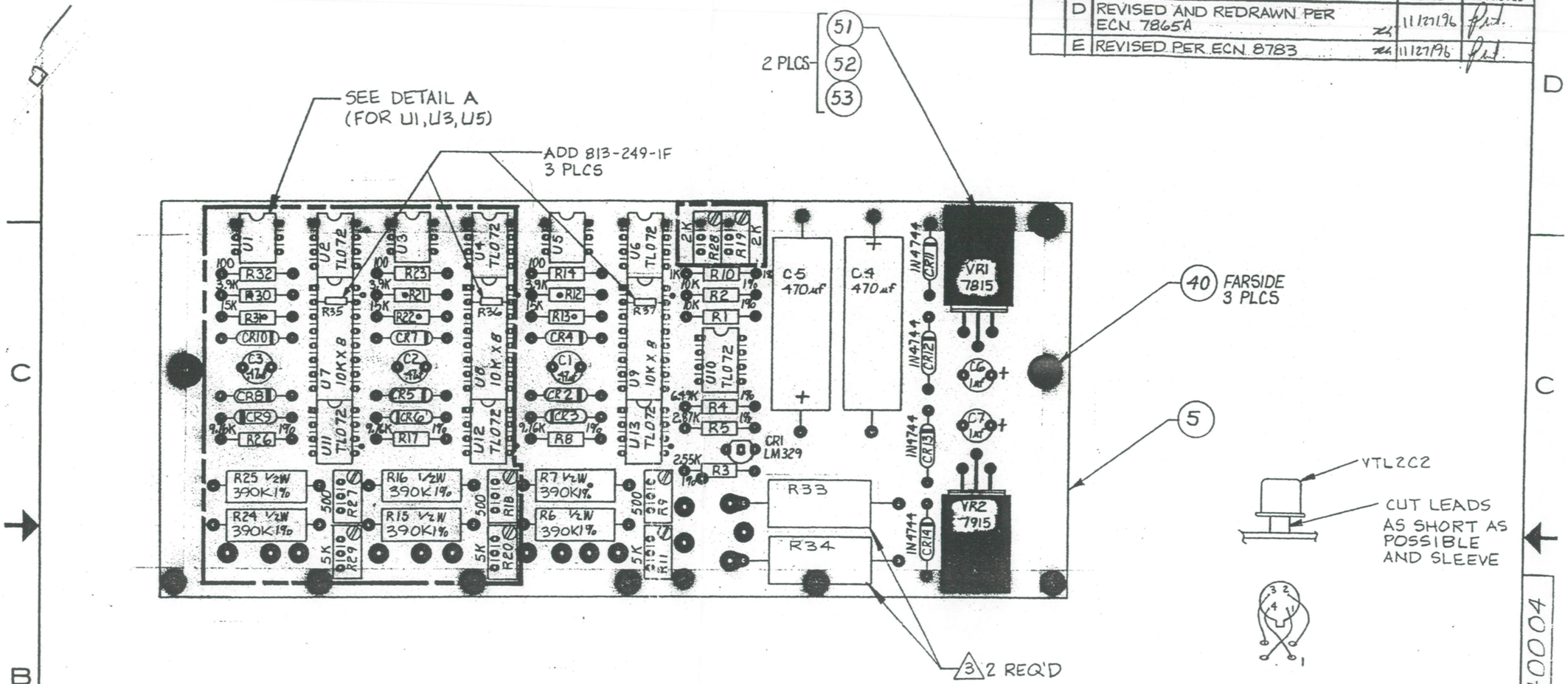


Figure 5-4. Model 400SD/SP Phase Board Assembly Drawing

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	D	REVISED AND REDRAWN PER ECN 7865A	11/27/96	Pat.
	E	REVISED PER ECN 8783	11/27/96	Pat.



-01 SHOWN (3 PHASE)

-02 SAME EXCEPT COMPONENTS SHOWN IN PHANTOM NOT INSTALLED (1 PHASE)

3 INSTALL 1K, 2W RESISTORS FOR SINGLE PHASE, 560Ω, 2W FOR 3-PHASE

2. DIODES ARE IN914.

1. RESISTORS ARE IN OHMS, 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED.

NEXT ASSY.	USED ON
	400SP
	400SD

APPLICATION

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON:

DECIMALS	FRACTIONS	ANGLES
.XX ± .03	± 1/32	± 1/2°
.XXX ± .010		

DO NOT SCALE THIS DRAWING

MATERIAL:

FINISH:

CONTRACT NO.

FIRST MADE FOR:

APPROVAL		DATE
DRAWN	JAY REEVES	8-20-82
CHECKED		8-20-82
PROJ ENG		8-24-82
QA-REL		

ELGAR
an Onan power systems company

ASSY, SERVO BOARD, 400SD/SP

SIZE	CODE IDENT. NO.	DRAWING NO.	REV
C	[illegible]	5040004	E

SCALE 5-11/5-12 SHEET 1 OF 1

5040004

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ENG'R RELEASE	11-[illegible]-92	[illegible]
	B	REVISED PER ECN 7865	11/27/96	[illegible]

10V
10V RET
- REF
A PHASE INPUT
B PHASE INPUT
C PHASE INPUT
A SENSE
SENSE COM
B SENSE
C SENSE
+42V
-42V
A COM

R3 2.55K 1%
R1 10K, 1%
REMOVE FOR 260V RANGE
R2 10K, 1%
R10 1K, 1%
CR1 LM329BZ
R4 6.49K 1%
R5 2.87K 1%
10V REF
U10 TL072
U9 10K
U6 TL072
R14 100
A Ø OUTPUT
R12 3.9K,
R13 15K,
CR4
C1 .47µF
R11 5K 20T
A OPEN
R35 2.49K, 1%
U5
R19 2K 20T
U8 10K
U4 TL072
R23 100
B Ø OUTPUT
R21 3.9K,
R22 15K,
CR7
C2 .47µF
R20 5K 20T
B OPEN
R36 2.49K, 1%
U3
R28 2K 20T
U7 10K
U2 TL072
R32 100
C Ø OUTPUT
R30 3.9K
R31 15K
CR10
C3 .47µF
R29 5K 20T
C OPEN
R37 2.49K, 1%
U1
U13 TL072
U12 TL072
U11 TL072
R6 390K 1/2W 1% 25PPM
R7 390K 1/2W 1% 25PPM
R8 9.76K 1%
R9 500 20T
R15 390K 1/2W, 1% 25PPM
R16 390K 1/2W, 1% 25PPM
R17 9.76K 1%
R18 500 20T
R24 390K 1/2W, 1% 25PPM
R25 390K 1/2W, 1% 25PPM
R26 9.76K 1%
R27 500 20T
CR2 CR3 CR5 CR6 CR8 CR9
R33 6Ω
R34 6Ω
VR1 7815 IN OUT COM
VR2 7915 COM IN OUT
CR11 IN4744
CR12 IN4744
CR13 IN4744
CR14 IN4744
C4 470 35V
C5 470 35V
C6 1µF
C7 1µF

⚠6 560Ω/2W FOR 30, 1K/2W FOR 1Ø

5. PER DES. LAST USED: C7, CR14, R34, U13, VR2.
4. ALL DIODES ARE IN914.
3. CAPACITANCE IS IN MICROFARADS.
2. RESISTORS ARE 1/4W 5%
1. RESISTANCE IS IN OHMS

NOTES: (UNLESS OTHERWISE SPECIFIED)

CONTRACT NO		
FIRST MADE FOR: END023		
APPROVAL	DATE	
DRAWN CHARITY	6-82	
CHECKED [illegible]	8-82	
PROJ ENG [illegible]	8-82	
QA REL		

ELGAR
an Chant power systems company

SCHEMATIC-
SERVO BOARD 400SD/SP

SIZE	CODE IDENT. NO.	DRAWING NO.	REV
D	25965	6040004	B

SCALE ~ SHEET 1 OF 1

5-13/5-14

SECTION VI
REPAIR PARTS LIST

6.1 GENERAL

6.1.1 This section contains a listing of all parts necessary for factory authorized repair of the unit. Parts are located on the diagrams in Section V and correlated on the parts list by using their reference designators.

6.2 SPARE PARTS ORDERING

6.2.1 When ordering spare parts, specify part name, part number, manufacturer, component value and rating. If complete assemblies are desired, contact:

ELGAR
Repair Department
9250 Brown Deer Road
San Diego, CA 92121-2294
1-800-733-5427
Tel: (858) 450-0085
Fax: (858) 678-4482
www.elgar.com

Specify assembly number, instrument series number and instrument name when ordering.

SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER NAME	MANUFACTURER PART NUMBER	ELGAR PART NUMBER
C 23	10 pF	Cap Mica	5%	CDE	DM15-100J	820-100-05
C33	33 pF	Cap Mica	5%	CDE	DM15-330J	820-330-05
C30,16,18	47 pF	Cap Mica	5%	CDE	DM15-470J	820-470-05
C17	15-60 pF	Cap Var		Erie	538-011F 15-60	828-015-60
C11*,32	.001 uF	Cap Disc		Centralab	DDM102	821-102-00
C19	.01 uF	Cap Disc		Centralab	DDM103	821-103-00
C2-4,7-10,24, 28,29,31	.1	Cap Disc	5%	Sprague	HY550	821-104-05
C20	1000 pF	Cap Mica	5%	CDE	DM15-102-J	820-102-05
C12*	.022 uF	Cap Mylar	5%			822-223-53
C13*	.22 uF	Cap Mylar	5%			822-224-53
C21,15*	470 pF	Cap Mica	5%	CDE	DM15-471J	820-471-05
C1	470 uF	Cap Elect	16V	Sprague	501D478F016TV	824-478-01
C8,14*,35	10 uF	Cap Tant	20V	Sprague	196D106X0020JA1	834-106-41
C5,6	100 uF	Cap Elect	50V	Sprague	500D107G050DH7	824-107-71
CR6,7		Diode		IN914	IN914	844-914-XX
CR1,2,8,5		Diode			IN4004	845-400-4X
CR3,4		Diode			IN4749A	843-474-9A
U3		Dual NAND		TI	SN74LS20N	849-LS2-OX
U16*		Dual D F/F		TI	SN74LS74N	849-LS8-4X
U6,7,8		Quad EX OR		TI	SN74LS86N	849-LS8-6X
U15*		Dual Timer		TI	SN74LS123N	849-LS1-23
U1,2,4,5		Rate Mult		TI	SN74167N	849-741-67
U10,11,12		Bin Ctr		TI	SN74LS193N	849-LS1-93
U13		Dual Ctr		TI	SN74LS390N	849-LS3-90
A1,2		Dual Op-Amp		TI	TL072CP	849-TL0-72
U14		8 BIT DAC		Signetics	NE5008N	849-N50-08
*Not applicable to 400SP. #Not applicable to 400SD.						
K1	6V Coil	Relay	3 Pole	Douglas Randall	6MG 3A	861-6Mg-3A
Q5		Transistor NPN		Motorola	MPSA13	833-MP8-III

SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER		ELGAR PART NUMBER
				NAME	PART NUMBER	
U9		Sine Prom		Elgar		849-SA2-5D
VR2		T092 Reg	+10V	T1	UA78L10ACP	849-78L-10
VR3		T092 Reg	+15V	T1	UA78L15ACP	849-78L-15
VR4		T092 Reg	-15V	National	LM320L2	849-LM3-20
DS1*		Red LED		H.P.	5082-4655	848-655-02
Q1,Q2*		Transistor,NPN			2N3568	835-356-8X
Q3		Transistor,FET		Signetics	SD213DE	842-SD2-13
Q4		Transistor			2N3643	835-364-3X
R23*,24*	510	Res ¼W	5%	Allen-Bradley	RC07GF511J	801-511-05
R21*	3.3M	Res ¼W	5%	Allen-Bradley	RC07GF335J	801-335-05
R9,25,26,49,58	1K	Res ¼W	5%	Allen-Bradley	RC07GF102J	801-102-05
R33	680	Res ¼W	5%	Allen-Bradley	RC07GF681J	801-681-05
R22*,34,47	10K	Res ¼W	5%	Allen-Bradley	RC07GF103J	801-103-05
R14*,61	47K	Res ¼W	5%	Allen-Bradley	RC07GF473J	801-473-05
R13*,15*,55*	3.9K	Res ¼W	5%	Allen-Bradley	RC07GF392J	801-392-05
R7,16*,50	1M	Res ¼W	5%	Allen-Bradley	RC07GF105J	801-105-05
R18*	7.5K	Res 1/8W	1%	Dale	RN60C7501F	813-750-1F
R11,12	13K	Res 1/8W	1%	Dale	RN60C1302F	813-130-2F
R19*	90.9K	Res 1/8W	1%	Dale	RN60C9092F	813-909-2F
R54	475 ohm	Res 1/8W	1%	Dale	RN60C4750F	813-475-0F
R56,57	100	Res 1/8W	1%	Dale	RN60C1000F	813-100-0F
R48	4.99K	Res 1/8W	1%	Dale	RN60C4991F	813-499-1F
R52,53	10K	Res 1/8W	1%	Dale	RN60C1002F	813-100-2F
R2	1K	Res 1W	5%	Allen-Bradley	RC32GF102J	803-102-05
R1	680	Res 2W	5%	Allen-Bradley	RC42GF681J	804-681-05
R10,17*	20K	POT 1T		Spectrol	63P503	819-203-63
R8,20*,51	100K	POT 1T		Spectrol	63P104	819-104-63

SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER		ELGAR PART NUMBER
				NAME	PART NUMBER	
R45	500	POT 1T		Spectrol	63P501	819-501-63
R59,60	2.2K	Resistor	¼W, 5%	Allen Bradley	RC07GF222J	801-222-05
R60	22K	Resistor	¼W,5%	Allen Bradley	RC07GF223J	801-223-05
R19A (option)	383K	Resistor	1/8W,1%	Dale	RN60C3833F	813-383-3F
RP1,2	10K	9 Res DIP	5%	Beckman	785-1-R10K	818-103-5P
RP3	10K	8 Res DIP	1%	Beckman	698-3-R10KF	818-103-DR
S1-4*		BCD SW		Std Grigsby	14895MP/ REL-10-1	860-BCD-09
S7*		1 Pole 3T Roty		Centralab	1461	860-146-1X
S5,6#		8 Pos DIP SW		CTS	206-8	860-206-8X
T1		Transformer	16V	Signal	ST4-16	850-ST4-16
Y1	10.24 MHz	Crystal		Moniter	MC18A-32-10.24 MHz	864-102-4X

5040003 400SD/SP PHASE BOARD

SCHEMATIC DESIGNATION	VALUE	DESCRIPTION OR TYPE	RATING	MANUFACTURER NAME	MANUFACTURER PART NUMBER	ELGAR PART NUMBER
C5	10 pF	Cap Mica	5%	CDE	DM15-100J	820-100-05
C8,10	100 pF	Cap Mica	5%	CDE	DM15-101J	820-101-05
C7	1000 pF	Cap Mica	5%	CDE	DM15-102J	820-102-05
C6	330 pF	Cap Mica	5%	CDE	DM15-331J	820-331-05
C4	.001	Cap Disc		Centralab	DDM102	821-102-00
C1,2,3	.1	Cap Disc		Sprague	HY550	821-104-05
Q1		Transistor FET		Signetics	SD213DE	842-SD2-13
R7	1K	Res ¼W	5%	Allen-Bradley	RC07GF102J	801-102-05
R8	1M	Res ¼W	5%	Allen-Bradley	RC07GF105J	801-105-05
R21	68	Res ¼W	5%	Allen-Bradley	RC07GF680J	801-680-05
R1,2	1K	Res 1W	5%	Allen-Bradley	RC32GF102J	803-102-05
R5	4.75K	Res 1/8W	1%	Dale	RN60C4751F	813-475-1F
R3,4	10K	Res 1/8W	1%	Dale	RN60C1002F	813-100-2F
R15,18,19,20	50K	Res 1/8W	.25%	Dale	RN60C5002C	814-500-2C
R12	73.2K	Res 1/8W	.25%	Dale	RN60C7322C	814-732-2C
R13,14	100K	Res 1/8W	.25%	Dale	RN60C1003C	814-100-3C
R6,10	500	POT 1T		Spectrol	63P501	819-501-63
R9	100K	POT 1T		Spectrol	63P104	819-104-63
U1		Cosine Prom		Elgar		849-CA2-5D
U2		8 BIT DAC		Signetics	NE5008N	849-N50-08
U3	10K	8 Res DIP		Beckman	698-3-R10KF	818-103-DR
A4,5,6		Dual OP-AMP		TI	TL072CP	849-TL0-72

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